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AIRCRAFT NUCLEAR PROPULSION PROGRAM

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AIRCRAFT NUCLEAR PROPULSION PROGRAM

Report of the Joint Committee on Atomic Energy

I. Introduction

Public hearings on the aircraft nuclear propulsion program (ANP) were held by the Research and Development Subcommittee of the Joint Committee on Atomic Energy July 23, 1959. This was the first time in the 13-year history of the program that hearings had been held in public session.

The 36 previous meetings of the committee on this subject were held in closed session at the request of the executive branch on the basis of national security considerations. However, in view of the continuing lack of a definitive plan for achieving nuclear flight and a prospective reorientation of the program which would remove existing target dates for technical objectives, some members of the committee considered that the time has come for public discussion of the ANP program so as to provide for a better public understanding of the problems and issues involved.

It was believed that such public hearings could now be held without endangering the national security. On the contrary, it was felt that public hearings at this time would, in fact, enhance the national security through an informed public opinion.

The hearings culminated 11 years of consideration and discussion of the ANP program by the Joint Committee. During these years the committee has lent its active support to this project on recognition of the vital potential of nuclear energy for aircraft propulsion.

Especially in the military sphere, some committee members felt that a need exists—and will continue to exist for some time—for a means of propulsion which will give military aircraft the range and endurance which are not possible with conventional, chemically fueled aircraft. With the availability of nuclear propulsion, whole new dimensions would be added to the spectrum of manned flight, opening up entire new areas for strategic and reconnaissance applications.

Over the years the ANP program has been marked by a series of ups and downs in terms of objectives, financing, and program guidance. The program has been characterized by changes in policy direction and lack of firm objectives. For example, there is apparently no firm requirements by the Joint Chiefs of Staff at present, although the Joint Chiefs have expressed the view that flight testing is desirable when such flight becomes technically feasible. (See p. 8.) Despite these difficulties, steady technical progress has been made by the working scientists and engineers in the field and technical objectives have, in general, been met on schedule. It may well be that future technical progress in the program will require a shifting of primary responsibility for achievement of first flight from the Defense Department to the Atomic Energy Commission, at least through the flight feasibility and demonstration stage.

Appearing at the full day of public hearings were representatives of the Atomic Energy Commission and the Department of Defense, who share responsibility for the conduct of the program. Witnesses included Maj. Gen. Donald Keirn, Director of the ANP project; Philip B. Taylor, Assistant Secretary of the Air Force for Materiel; Gen. Thomas White, Air Force Chief of Staff; Fred A. Bantz, Under Secretary of the Navy; Adm. John T. Hayward, Deputy Chief of Naval Operations for Development; John A. McCone, Chairman of the Atomic Energy Commission; Hon. Thomas Gates, Deputy Secretary of Defense; and Dr. Herbert York, Director of Defense Research and Engineering. Brief statements were also received from representatives of the major contractors contributing to the program, including the General Electric Co., Pratt & Whitney Co., and Convair Division of the Dynamics Corp.

The printed record of the hearings, which contains the oral testimony of the above witnesses and supplementary statements and materials for the record, will provide the public for the first time with a comprehensive description of the ANP program, including its history, present status, and discussion of plans for the future.

II. History of Program

As indicated in the detailed chronology attached to this report, the first study project on the ANP program was initiated under contract to the Air Force in May of 1946 by the Fairchild Engineer & Airframe Co. to explore the feasibility of nuclear-powered aircraft. This was the so-called NEPA project (nuclear energy for the propulsion of aircraft) which was located at Oak Ridge shortly after its inception. Over the next several years, the project was reviewed by various groups inside and outside the Government, including the Massachusetts Institute of Technology, which issued the so-called "Lexington Report" in September 1958, predicting the feasibility of nuclear flight in about 15 years.

In early 1951 the NEPA project at Oak Ridge was phased out after general feasibility was indicated and a decision was taken to shift the program to an industrial contractor, the General Electric Co., for development on a propulsion plant.

In mid-1951 the Defense Department informed the Joint Committee that the Joint Chiefs of Staff had established a military requirement for construction of a nuclear powerplant suitable for aircraft propulsion. By 1952 plans were underway to flight test a nuclear propulsion system in the 1956–58 period, utilizing a converted B–36 as a flying test bed. Later in the year the Office for Aircraft Nuclear Propulsion (ANPO) was established to coordinate AEC and Defense Department participation in the program, in line with suggestions by the Joint Committee.

In the spring of 1953 the first of the major cutbacks occurred. The Defense Department initially "canceled" the ANP program, but reconsideration of this decision was made following active intervention by the Joint Committee. As part of the reoriented program which followed, plans for a flying test bed were canceled and a series of "high temperature reactors experiments" (HTRES) were initiated to develop reactor systems for a direct cycle nuclear propulsion plant. Work was also begun by the Pratt & Whitney Co. and Oak Ridge National Laboratory on development of an indirect cycle system as an alternative technical approach for aircraft propulsion.

In 1954 the Joint Committee transmitted a report to the President, Secretary of Defense, and Chairman of the Atomic Energy Commission calling for a sharply stepped-up effort to achieve nuclear flight. A high performance aircraft program was initiated a year later, aimed at testing a prototype propulsion plant about 1959.

In the years that followed steady technical progress was made on the "heater" reactor experiments, but the high performance aircraft program was canceled, following a technical reappraisal of the status of the art and a review by the Budget Bureau.

In the fall of 1957 proposals were made in the Defense Department to the Deputy Secretary of Defense for an "early flight" program utilizing a modified conventional military aircraft as a flying "test

bed." The Joint Committee gave strong support to this proposal and, in a letter to the President, Chairman Price urged a vigorous program looking toward early nuclear flight, both as a military requirement and also to bolster U.S. scientific prestige following the launching of the Soviet sputnik.

After some indications of a favorable reception to these proposals, the President's Adviser on Science and Technology appointed a special panel early in 1958 to review the program. This was the eighth in a series of committees in the executive branch which has been asked to review the program since its inception in 1946. This panel, which was later reconstituted as an advisory group to the Defense Department, recommended against proceeding with a flight program.

In early 1959, the chairman and vice chairman of the Joint Committee, together with the chairman of the Research and Development Subcommittee, issued a joint statement again urging adoption of an early flight program. In April, at the suggestion of the committee, Deputy Defense Secretary Quarles and Chairman McCone of the AEC accompanied members of the committee on a personal inspection tour of the General Electric project in Evendale, Ohio, for a briefing on progress in development of the direct cycle propulsion system. The next month, following a top-level meeting of Defense Department and AEC officials, instructions were given to prepare a draft recommendation to the President with regard to an early flight program.

Following the untimely death of Secretary Quarles, this procedure was set aside and the Joint Committee learned that a major reorganization was in prospect, including the abolishment of existing target dates for a ground test prototype propulsion system and abandonment of the present technical program aimed at development of such a system. The committee thereupon announced that public hearings would be held in mid-July.

III. Major Points Covered

A. PROGRAM PURPOSE AND MILITARY REQUIREMENTS

It was generally agreed by all witnesses that a basic need exists for the development of a reactor-engine propulsion system capable of providing nuclear flight for military aircraft. There were differences of opinion as to how firm a requirement there is for such a nuclear-powered aircraft and what time scale is appropriate.

With regard to the propulsion systems, research and development is currently being carried out on two basic concepts: (1) The direct cycle system whereby air, which is used to remove the heat from the reactor core, is employed directly to provide the necessary thrust, and (2) the indirect cycle system whereby heat is transferred indirectly to the air from the reactors liquid metal coolant system and the heated air then used to provide thrust. The majority of funds and effort to date have been spent on the direct cycle development program but plans are now underway to increase the indirect cycle effort looking toward development of advanced reactor materials.

There has been considerable confusion as to terminology applying to the programs, particularly with regard to the word "useful" when applied to first nuclear flight. Several witnesses including the project director, pointed out, in this connection, that specific requirements are not necessarily needed in a development program aimed at demonstrating feasibility of new propulsion systems. They emphasized that in all such programs intermediate steps, including limited first flight are necessary as basic stages in the development of militarily useful aircraft of full operating capability.

It was clear from the testimony that while no general operational requirement has been approved by the Defense Department, the Air Force has a requirement for a continuously airborne missile launching and low-level penetration aircraft flying at high subsonic speeds. This is the so-called CAMEL system whose operational requirement (GOR 172) was issued in October 1958. The Navy has an interest in a subsonic turboprop system installed in a large flying boat for reconnaissance and antisubmarine warfare purposes.

It was noted that "General Operational Requirements" are in the process of being replaced in the Air Force by (*a*) "Specific Operational Requirements," describing in specific terms the characteristics of a weapons system required for near term needs which is technically ready for production; and (*b*) "Systems Development Requirements," covering new systems presently beyond the technical state of the art but for which an operational requirement is foreseen.

General Keirn, director of the ANP project, expressed the view that a recent Joint Chiefs of Staff report on the ANP program supports a system development requirement but Under Secretary Gates stated that the Joint Chiefs had established no requirement for a nuclear aircraft. (See p. 8.)

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In commenting on the future need for manned military aircraft, General White, the Air Force Chief of Staff, had this to say:

> Results of numerous studies have convinced me that for the foreseeable future a requirement will continue to exist for an advanced, operationally-flexible, manned, intercontinental, recoverable, recallable strategic aerospace weapon system which can penetrate and attack the enemy's military forces. Surface-to-surface missiles are expected to increase in reliability, accuracy and flexibility of employment to a point where they will represent a significant contribution to the overall strategic effort. However, there are certain fundamental capabilities which I consider mandatory as a part of our strategic posture and which are not characteristic of missiles. These dictate the retention of the manned weapon system as an integral part of our strategic force structure.

With regard to nuclear propulsion for manned aircraft, he said:

> Although the Air Force does not now forecast each specific configuration which future military weapons will eventually assume, we are certain that vital military applications will derive from the development of nuclear propulsion * * *. While it is too early to define the exact weapon system which may evolve, applications now foreseen emphasize the military development requirement for nuclear-powered aircraft.

B. PROGRAM OBJECTIVES

A broad objective of the ANP program has, from the beginning of the program in 1946, been to develop a strategic weapons system which would eliminate the range and endurance limitations of chemical aircraft systems. Within this broad objective there have been wide fluctuations in flight test philosophy, resulting from frequent changes in emphasis and direction of the program by the Department of Defense. But during this time, technical objectives have been generally met by the contractors in the field and their efforts have been directed toward ultimate development of a propulsion system suitable for a useful military aircraft.

It is to be noted that the period since 1946 has been one of major transition in the Nation's military requirements. The period also has been one of swift technological change, characterized by the emergence of ballistic missile systems capable of both strategic and tactical employment. These considerations have imposed upon military planners the difficult and fluctuating burden of allocating available funds between costly commitments for wide range military power in being able to meet the crises of the day and research and development programs to meet the crises of the future. Accordingly, the ANP program has, from time to time, shifted position in the competition for priority.

Major difficulties have arisen, particularly among the contractors in the field, from a lack of clearly defined guidance as to what the objectives of the program are and what time scale, if any, is being used to serve as a measure of progress toward successful completion. Chairman McCone of the AEC noted in this regard:

> A clearly stated first milestone toward which the program could be directed would, in my opinion, provide best assurance of its early attainment and would be a real stimulant to all personnel involved in the program.

Later in the testimony, Dr. York described the general outlines of the present program, as it has been reoriented and stated that objectives for the immediate future should be—

> (a) Continue the development of only such reactors and powerplants as would be suitable for militarily useful nuclear flight.

(*b*) Increase the effort on the indirect cycle program so as to determine its potentialities at an earlier date than previously contemplated.

(*c*) Defer initiation of a specific flight program until (1) one of the advanced powerplants is established as feasible and potentially useful, and (2) a flight program can be instituted without seriously interfering with the development of militarily useful powerplants.

In response to questioning, Dr. York observed that detailed aspects of the reoriented program have yet to be worked out and that for the time being no schedules for completion are contemplated.

C. TARGET DATES

It was apparent from the testimony of Defense Department officials that no target dates are established for the program at the present time, either for a ground test prototype propulsion system or for first flight. A reorientation of the program, referred to above, has resulted in virtual abandonment of the "available materials" program for a direct cycle ground test prototype reactor and consequent elimination of the previous ground test target date of mid-1961. It was indicated that this reorientation would entail a delay of about 2 years in construction of such a prototype.

Similarly, the Navy confirmed that no target dates for the Navy program had been set. Witnesses testified that the Navy did not desire to spend additional funds of its own on an accelerated program, but stated that if the Defense Department had agreed to provide the necessary funds for the program proposed by the Navy, a flying boat could have been flown in 1962 or 1963 as a test bed.

Considerable comment was made on the importance of establishing firm target dates, both for ground test and actual flight, as a guide and incentive to the working scientists and engineers in the field. For example, Chairman McCone of the AEC stated:

> I would think that the determination of the nuclear-powered aircraft in the air desired at a particular date would be the greatest stimulus to the research and development effort.

The position of the project director, General Keirn, was expressed in this way:

> When you reach the stage where you can technically move into a flight test program, it is time to do it because if you postpone it, your basic costs are continuing to run but the costs of moving into the flight test program essentially are unchanged.

General Keirn pointed out further that the test-flight program will be delayed by whatever length of time it takes for a decision to be made to move into it, and that from that point on it would take some 4½ to 5 years to reach nuclear flight. Chairman McCone agreed that the 5-year flight program could only be initiated after a decision is actually taken to fly, whether it is this year or 5 years from now.

The prime contractor for the direct cycle propulsion system development program made this comment regarding the importance of target dates:

> The need stands today for such a flight objective—as concrete and definite as possible. The ANP program, up to now, has never had this type of definite long-term objective which has stayed in existence long enough for it to be reached, and the program thus put in a position where a real evaluation of its potential could be made.

Dr. York summed up the Defense Department attitude on the question of target dates by stating:

> I would rather be told what the performance wanted was rather than the date. You cannot specify both * * * I myself would choose performance and that is the way I intend to try to do this.

D. EARLY FLIGHT

There was extensive discussion during the course of the hearings on the question of so-called "early flight" of a nuclear plane as a step toward development of a militarily useful aircraft. Proponents of the early flight concept pointed out that historically, aviation development has occurred on a step-by-step basis and that prototype aircraft are always limited-performance vehicles to begin with. The utility of early models is to learn what problems need to be overcome as a necessary prelude to achievement of full operating capability.

Strongly advocating this approach, General Keirn had this to say:

> It is my personal conviction that we have reached a point where it is now appropriate to commence the design and construction of an experimental aircraft suitable for flight testing the propulsion systems presently under development and of evaluating the operational characteristics of such an aircraft as a first step in determining the manner in which the unique capabilities of nuclear power in the air can best be utilized.
>
> Commencing such flight testing with a propulsion system, even though it does not meet the military performance as specified in General Operational Requirement No. 172 (CAMAL system), still serves the purpose of developing the powerplant external to the reactor core, the powerplant-airplane combination as a complete machine, and permits us to tackle the many problems of flight, maintenance, servicing, and problems associated with operational techniques irrespective of whether or not the aircraft would be flown at maximum performance. I believe that these problems can be solved concomitantly with the development of improved reactor cores and that these improved cores can subsequently be installed to provide full performance of the aircraft.

The Chief of Staff of the Air Force, General White, concurred in in this view, pointing out that only through a flight-development phase will pertinent information and data be obtained in these areas of operational uncertainty so that logical decisions concerning possible follow-in weapon systems can be made. In response to a question, General White stated his personal opinion that the Joint Chiefs of Staff, on the basis of recent discussions of the early flight question, believe it to be militarily desirable to undertake a flight-test program as an extension of the present ANP program, as soon as such a flight program is considered to be technically feasible.

Later in the testimony, Secretary Gates noted that the Joint Chiefs of Staff have—

> expressed their conviction that there is considerable military potential in the nuclear-powered aircraft and that early achievement of the capability for nuclear flight would be in the national interest.

Secretary Gates went on to state, however, that the Joint Chiefs were—

> unable at this time to establish a military requirement for nuclear-powered aircraft or to define the specific weapons systems for which it would be used. With respect to the future course of the development program, the Joint Chiefs advised that the present program should be extended to include flight test as soon as technically feasible.

It was noted, in this connection, that Secretary Douglas of the Air Force had made this comment in a letter to the Joint Committee in June 1957:

We are convinced that early nuclear-powered flight testing is an important part of the program. It is believed that accomplishment of actual nuclear flight will crystalize and clarify many of the problems concerning radiation hazards, nuclear powerplant operation and maintenance, and the actual capabilities of nuclear-powered aircraft.

Chairman McCone of the AEC expressed the view that—

flight testing of a nuclear-propulsion system would provide useful test data for later systems of improved performance.

He then went on to say, in response to a question:

I think all things considered, Sir, that to proceed with (a ground and flight testing) program would stimulate this whole developmental program. I realize, however, that the decision in this respect is a decision to be made by the Department of Defense which is the using agency.

Reference was also made during the course of the testimony to a report by the AEC General Advisory Committee on June 1959, which said in part:

The work by General Electric (prime contractor for the direct cycle propulsion system) has now reached the point where it appears likely that fuel elements can be developed which will be capable of making the performance of the direct cycle reactor high enough to be useful for propulsion of military aircraft. * * * If the Department of Defense is in favor of proceeding with this system, then the Reactor Subcommittee recommends that the necessary steps be taken to develop the XMA * * * powerplants by General Electric and that these steps include provision for flight testing and demonstration of these propulsion systems as proposed by General Electric and that these steps include provision for flight testing and demonstration of these propulsion systems as proposed by General Electric and Convair.

Opposition to the early flight concept, voiced principally by Secretary Gates and Dr. York, was based primarily on what they considered to be the inadequacy of available materials in the direct cycle propulsion system and what they believed were serious limitations in their growth potential for higher performance, as well as funding considerations. The nature of this opposition is described in the following sections, namely, E, F, and G.

E. TECHNICAL FEASIBILITY AND ADEQUACY OF PRESENT MATERIALS

There was general agreement among witnesses that materials which are now available for the reactor in the direct cycle propulsion system are adequate to sustain early nuclear flight. There were, however, differences of opinion as to whether the performance to be gained from these materials and their growth potential were adequate to warrant proceeding with an early flight program at this time.

General Keirn expressed the belief that a nuclear-powered aircraft—

can be achieved within the state of the art and on a predictable time basis.

Chairman McCone made this observation about the feasibility of a nuclear flight:

Our fundamental technology has now been brought to the point that the question is no longer "can we fly on nuclear power?" but rather, "In what manner do we wish to fly on nuclear power, when and with what kind of performance?"

A somewhat different view was offered by the Assistant Secretary of the Air Force, Mr. Taylor, who stated:

> We all agree that it is technically feasible to fly with an atomic powerplant. I think what we are talking about is how good a powerplant and how good an airplane are we likely to develop within the time limit.

Secretary Gates, in referring to conclusions of a study by the Defense Department's Weapons Systems Evaluation Group, stated that nuclear propelled aircraft do not offer a substantial margin of improvement over chemically fueled aircraft. He added that propulsion systems constructed of materials that are essentially in hand at the present time will fall far short of chemically fueled competitors.

Dr. York, testifying in the same vein, expressed the view that an aircraft with a propulsion system utilizing available materials cannot be considered as a militarily useful vehicle and the particular powerplant involved would have little or no growth potential. Together with other witnesses, Dr. York agreed that such a powerplant could probably sustain nuclear flight, but he personally felt that such flight would only be marginal in nature.

A representative of the General Electric Co., chief contractor for the direct cycle propulsion system, had this to say about the present status of development on the direct cycle system:

> We now have in hand the technology and capability to provide an aircraft nuclear powerplant of the direct cycle turbojet type which can perform in the air and on the delivery schedule which matches that for the design, fabrication and test of an experimental airplane. This powerplant is currently in final design and initial stages of manufacture.

F. GROWTH POTENTIAL AND PERFORMANCE

As indicated in the sections above, a major argument advanced against early flight was the contention that performance and growth potential of available materials in the direct cycle propulsion system was so marginal that it would be desirable to wait for the development of better reactor materials.

In contrast to this line of argument, General Keirn and contractor representatives contended that operational, servicing, and maintenance problems can be solved at the same time as improved reactor cores are developed. It was emphasized that successively improved reactor cores can be installed subsequently in the same prototype airframe without undue technical difficulty. Thus, General Keirn stated in this connection:

> Waiting for the full performance cores before initiating such a flight test program needlessly delays the program, and in the long run is a more costly procedure. We can tackle many problems with the reduced temperature reactor core which we now know how to build and have many of those problems associated with the flight test phase solved by the time we are ready to install a core which will operate at a temperature necessary to provide military power.

A representative of the prime contractor for the direct cycle propulsion system put it this way:

> It has been our plan and philosophy of development to try to generate the mechanical systems and control systems, etc., so that they could be readily used with improved materials in the reactor itself * * *. The basic hardware, it is our intention, must be made sufficiently universal so that improvements in reactor technology can be incorporated with a minimum of change.

Opposing this view, Dr. York commented that changing the reactor core could present technical difficulties and that it is "not a minor thing" to substitute a core with advanced materials for one with available materials in the same propulsion system. He then went on:

* * * Many of the results and much of the experience which would be obtained from a premature flight using interim results and possibly dead end design are very likely to be erroneous and misleading * * *. The powerplant using the available materials has little or no growth potential.

Supporting this viewpoint, Secretary Gates stated:

While it is technically feasible to fly an airplane, the airplane we fly under this program is a very limited airplane in performance and flight both. It leads to nowhere as far as further development of the reactor that is flying is concerned * * * it does not produce an airplane reactor that has growth potential for reasonable performance * * *. Everyone agrees that at the proper time we should try out an airframe. (The proper time would be) when we have a reactor that is possible of greater growth than the reactor we would have to use and concentrate on to fly this first airplane.

G. FUNDING AND BUDGET CONSIDERATIONS

It was pointed out at the hearings that during the 13 years which the aircraft nuclear propulsion program has been underway, over $800 million has been spent to date directly on the program.[1]

Of this total expenditure the Air Force portion has been about $460 million and the AEC portion, about $380 million. In addition, the Navy has spent about $12.5 million, mostly in studies of applications and systems. Included in these totals are $166 million for facilities, the Air Force having spent $114.5 million and the AEC $51.5 million. Current rate of expenditure is about $150 million per year.

TABLE I.—*ANP manned aircraft program summary, fiscal years 1946–60*

USAF-NAVY-AEC

[In millions]

Fiscal year	Operations	Facilities	Annual total	Cumulative total
1946	$1.3		$1.3	$1.3
1947	2.0		2.0	3.3
1948	6.2		6.2	9.5
1949	6.9		6.9	16.4
1950	6.7		6.7	23.1
1951	8.3	$0.5	8.8	31.9
1952	20.7	6.2	26.9	58.8
1953	40.6	18.6	59.2	118.0
1954	21.5	3.3	24.8	142.8
1955	46.8	7.1	53.9	196.7
1956	96.8	60.4	157.2	353.9
1957	141.0	45.0	186.0	539.9
1958	130.0	11.4	141.4	681.3
Subtotal	528.8	152.5	681.3	
1959 (estimated)	139.7	19.2	158.9	840.2
1960 (estimated)	143.4	7.0	150.4	990.6
Total	811.9	178.7	990.6	

[1] In addition to this amount, about $10 million has been spent for collateral projects, such as the reactor facilities at Wright-Patterson Air Force Base.

TABLE 2.—*ANP manned aircraft program by agency, fiscal years 1946–60*

[In millions]

Fiscal year	USAF		Navy, operations	AEC	
	Operations	Facilities		Operations	Facilities
1946	$1.3				
1947	2.0				
1948	6.2		($1.0)		
1949	6.9		(.5)		
1950	5.3			$1.4	$0.5
1951	2.8			5.5	.5
1952	10.0	$6.0	(.5)	10.7	.2
1953	22.6	6.3	.2	17.8	12.3
1954	6.2	.2	.1	15.2	3.1
1955	22.4	6.4	.5	23.9	.7
1956	46.4	57.4	3.7	46.7	3.0
1957	66.1	35.6	1.5	73.4	9.4
1958	60.5	2.4	2.9	66.6	9.0
Subtotal	258.7	114.3	8.9	261.2	38.2
1959 (estimated)	63.4	5.8	3.5	72.8	[1] 13.4
1960 (estimated)	68.0	7.0	2.0	[2] 73.4	
Total	390.1	127.1	14.4	407.4	51.6

[1] Based on current program planning, the total amount may not be placed under contract during fiscal year 1959.
[2] Excludes $0.3 of prefinancing.

Figures in parenthesis above are Navy funds transferred to Air Force which are included in the Air Force amounts. These amounts are not included in the Navy total.

Between 85 and 90 percent of the total expenditure so far has been in the general area of propulsion work, with 10 to 15 percent spent directly on airframes, systems studies, and components, radiation effects, basic shielding measurements and so on.

With regard to funding in fiscal 1959, about $103 million was earmarked for work on the direct cycle program and about $17 million for the indirect cycle program.

It was estimated by the project director, General Keirn, that in addition to the current $150 million annual level of expenditure, an accelerated program looking toward early flight of two experimental aircraft would cost about $340 million spread over 4 to 5 years. It was brought out, that as the first increment in such an accelerated program, it was proposed to increase the Air Force and AEC's budget for fiscal 1960 by about $25 million apiece, bringing the Air Force total to about $101 million and the AEC total to about $98 million. It was proposed that the Defense Department provide an additional $45 million to cover initial work on airframe development.

In his testimony, General Keirn expressed the opinion that such additional outlays in the next 4 to 5 years for an accelerated program would not only save several years in the achievement of first flight but would also cost less in the long run.

In response to questioning, Assistant Secretary Taylor confirmed that budgetary considerations had played a substantial role in deciding not to proceed with a flight program at this time. He noted that a review of available powerplants would be made at the end of the present fiscal year which may lead to a flight test oriented program, adding that—

consideration of the availability of funds from the 1961 budget will also influence this decision.

In response to a question as to whether Dr. York would have gone ahead with a flight program if additional funds had been provided, Dr. York stated:

> Not on the basis of what I know about all the other things that other responsible groups, equally responsible with ANPO would like to see going further. I think there are plenty of other good places for money besides this one.

It was also brought out at the hearings that about $200 million has been spent to date on development of available materials for the direct cycle propulsion system which it was proposed to install in an early flight aircraft. Considerable knowledge and experience has been gained in this development effort which will have a useful application in other areas of the atomic energy program. In response to questioning, Dr. York indicated that while not all of the effort on available materials would be suspended, most of the emphasis from now on would be placed on the development of advanced materials, both for the direct and indirect cycle propulsion system. He added that on the basis of "theoretical convictions" concerning the advanced materials now under consideration," he believed there was a real possibility that a "useful" nuclear powerplant could be built.

H. NEW PROTOTYPE VERSUS MODIFIED TEST BED

During the course of the discussions, there was general agreement on the desirability of constructing a new aircraft for initial flight tests. There was some feeling, however, as reflected by Chairman McCone, that a modification of a conventional military plane might be preferable as the first test flight vehicle or "test bed."

In supporting the new prototype plane concept, General Keirn pointed out that even if there were no plan to build an aircraft which might serve as a prototype of an aircraft meeting some military requirement, it would be necessary, in the propulsion system development process, to put an experimental nuclear powerplant in some sort of a rframe for flight testing purposes.

Proposals to this effect were made to the Defense Department by both the Air Force and the Navy. Latest of these were in the fall of 1957 when the Air Force proposed a modified conventional tanker plane and the Navy a modified version of the British *Princess* flying boat.

General Keirn made reference in the course of his testimony to the decision in September 1951 to develop a direct cycle system for installation in two modified B–36 airplanes which were to be used as a flying test bed. It was recognized at that time that the reactor did not provide a suitable tactical powerplant but that the flight testing of this powerplant would permit attack on many of the problems of nuclear-powered flight, and provide the understanding through which advanced tactical powerplants could be produced. This flight test element of the program was rejected by the Department of Defense on the basis it would not provide directly for a militarily useful powerplant, and consequently did not warrant the dollar expenditure.

After weighing the various factors involved, General Keirn has concluded that a new airplane designed specifically for nuclear propulsion is the preferable airplane for test flight purposes. He noted, in this connection, that the same new airplane employed for test

purposes would also be useful in evaluating the military utility of the airplane.

Mr. McCone said he had expressed the hope that a shortcut could be found to flight testing by using an existing aircraft, but that others with competence in this area did not seem to believe that this is as useful or desirable as proceeding with a new airplane designed specifically for nuclear power. He maintained that a reasonably performing test bed plane could be useful for demonstration purposes, although it would obviously have little or no military utility to begin with.

I. PROGRAM ORGANIZATION AND ADMINISTRATION

During the course of his testimony, Secretary Gates noted that there had been some criticism in the past on the management of the aircraft nuclear propulsion program and that the matter was being jointly reviewed by the Defense Department and AEC with the view to determining whether the present management system should be altered. He stated that several alternatives were being discussed, including the possibility of setting up a board-of-directors-type management. Several members of the committee commended General Keirn and the staff for their conduct of the program and the question was raised as to whether the criticism referred to might more appropriately be directed to what the management had to work with in this program. It was agreed by all that unified technical direction of the program, which the Joint Committee had strongly recommended in previous years, is desirable to coordinate the activities of both AEC and the Defense Department, together with the major contractors.

IV. Conclusions and Recommendations

A. NEED FOR CONCRETE OBJECTIVES AND FIRM TARGET DATES

Committee hearings and historical review of the program indicate that concrete objectives and firm target dates are essential to provide working scientists and engineers in the field with clear guidelines for a research and development program and to give them the necessary incentives to press forward toward achievement of specified objectives, including target dates for a ground test prototype propulsion system and for first flight. It is recognized that such target dates may not, in fact, be met in every instance, but the impetus they provide constitutes an important factor in the eventual success of a program effort.

It is clear from the hearings and the history of the ANP project since its inception in 1946 that there has been a lack of concrete objectives and target dates either for a ground test prototype propulsion system or for early flight.

B. TECHNICAL PROGRESS

Technical progress in the program to date has been both positive and continuous. In general, technical objectives have been met on schedule.

C. DESIRABILITY OF EARLY FLIGHT

It is evident that early flight with materials now on hand would provide a powerful stimulus toward early development of a fully operational military aircraft propelled by nuclear energy. Many problems associated with nuclear flight could be met and solved through such early flight, with concurrent development of more advanced reactor cores to produce improved performance. The first test aircraft would not be designed to meet the requirements of a fully operational aircraft. It would, however, provide valuable information and possibly save time in the development of a useful military aircraft.

It is in the national interest to achieve nuclear flight as early as possible, not only to meet stated military requirements, but also to provide a boost to world confidence in America's scientific capabilities.

D. IMPORTANCE OF ADVANCED MATERIALS

In any programing effort to achieve early nuclear flight utilizing available materials, there should be continued emphasis on the development of advanced materials so as to insure a better performance and capability in the future. The recent technical advances made in the indirect cycle system appear most promising and it is the feeling of the committee that every effort should be made to push ahead with the proposed experimental reactor program.

E. NEED TO STRENGTHEN PROGRAM DIRECTION

General Keirn and his staff in the Aircraft Nuclear Propulsion Office have through the years performed valuable services in coordinating the efforts of the Atomic Energy Commission and the Defense Department, but the ANP Office has more often than not been given responsibilities without delegation of the actual authority needed to carry out these responsibilities effectively. The concept of coordinated direction of the technical program between the Defense Department and AEC has, in general, worked well since the establishment of the joint office and should be reinforced by firmer top-level support from both agencies.

F. POSSIBLE ALTERNATIVES

In view of statements by Department of Defense representatives that there is at present no general operating requirement by the Defense Establishment for a nuclear-propelled aircraft, and that the program, as it is presently constituted, is basically a research and development effort, the Congress may wish to consider the desirability of placing primary authority and responsibility for the conduct of the ANP program in the Atomic Energy Commission, which is well equipped to carry the program forward as a development effort through the flight feasibility and demonstration stage. Present cooperation with the Defense Department would be continued, under such an arrangement, but the primary emphasis of the program would be upon the development of a ground test prototype propulsion system and the flight testing of such a propulsion system in an experimental aircraft. Such an approach in the committee's opinion should prove out the feasibility of nuclear flight and would provide the basis for a judgment by the Defense Department on firm military requirements for a nuclear-propelled aircraft.

CLINTON P. ANDERSON,
CARL T. DURHAM,
RICHARD B. RUSSELL,
JOHN O. PASTORE,
ALBERT GORE,
HENRY M. JACKSON,
BOURKE B. HICKENLOOPER,
HENRY DWORSHAK,
GEORGE D. AIKEN,
WALLACE F. BENNETT,
CHET HOLIFIELD,
MELVIN PRICE,
WAYNE N. ASPINALL,
ALBERT THOMAS,
JAMES E. VAN ZANDT,
CRAIG HOSMER,
WILLIAM H. BATES,
JACK WESTLAND.

SEPARATE VIEWS REGARDING TIME SCHEDULING FOR EARLY NUCLEAR FLIGHT

Although we concur in the report's conclusion that early nuclear flight is in the national interest, we caution that the report's recommendation that it be accomplished "as early as possible" does not, to us, necessarily connotate either a "crash" program or a major step-up in present programming to overcome remaining technical problems.

In declaring that there is no question as to the feasibility of nuclear flight, Chairman McCone pointed out that the questions are, rather:

> * * * in what manner do we wish to fly on nuclear power, when, and with what kind of performance?

It is to be noted that the answers to each of the questions raised by Mr. McCone involve judgments based not alone on technical considerations, but on nontechnical ones as well.

The question of the manner in which we wish to fly on nuclear power involves a yet to be made decision as to where, in a spectrum ranging from a flying test bed to a completed weapons system, should early nuclear flight be aimed.

The question of when do we wish to fly on nuclear power involves considered judgment as to the relative priority call on the Nation's not unlimited financial and scientific manpower resources between the ANP program and many other military programs which may be of greater or lesser importance to the national interest.

The question of what kind of performance do we wish from early nuclear flight involves a considered determination of whether the Nation's highest interest lies in low performance flight with existing materials or better performance flight after development of better materials.

Some of the technical witnesses expressed opinions on these nontechnical questions which appeared to favor nuclear flight at the earliest possible moment. However, the principal witnesses actually responsible for decisions on nontechnical aspects, Deputy Defense Secretary Thomas S. Gates, Jr., and the Defense Department's Director of Research and Engineering, Dr. Herbert F. York, testified to the effect that the probable answers to them seem not at this time to place the ANP program in a time-scale "first priority" position for available funds and scientific manpower.

In this regard the report points out that the program has, from time to time, shifted position in the competition for priority amongst various military programs as changing international conditions since 1946 have dictated changes in the Nation's military requirements.

Thus, in concurring with the report's conclusion that early nuclear flight is in the national interest, we wish to make it clear that its recommendation to achieve it "as early as possible" should be taken to mean getting something in the air flying on nuclear power at the earliest moment technically possible only when technical and nontechnical considerations both clearly point to that interpretation.

In summary, we believe that amongst various military programs in the national interest, the ANP program should continue to take its place in an order of importance determined by best considered judgment of the Nation's highest interest, based on all factors involved.

BOURKE B. HICKENLOOPER.
HENRY DWORSHAK.
GEORGE D. AIKEN.
WALLACE F. BENNETT.
JAMES E. VAN ZANDT.
CRAIG HOSMER.
WILLIAM H. BATES.
JACK WESTLAND.

APPENDIX

Aircraft Nuclear Propulsion Program

CHRONOLOGY

1946

May..... First study project is initiated to explore feasibility of nuclear powered aircraft. This was the so-called NEPA project (Nuclear Energy for the Propulsion of Aircraft) undertaken for Air Force by Fairchild Engine & Airframe Co. Project located in Oak Ridge shortly after its inception.

1947

December..... Research and Development Board of the Defense Department recommended that the NEPA program proceed on a priority basis as a single unified and coordinated project with AEC.

1948

January..... President's Air Policy Commission recommends in its report (Finletter report) that steps to intensify research efforts on nuclear plane be taken immediately.

February..... Joint Committee holds first of 36 meetings on ANP program and receives briefing from Gen. Leslie Groves, Chief of Manhattan Engineering District.

March..... In a report to Congress, the Congressional Aviation Policy Board urges that program be accorded "the highest priority in atomic energy research and development * * *."

September..... Report prepared by Massachusetts Institute of Technology at request of AEC (Lexington report) predicted that a nuclear powered aircraft was feasible and could be achieved in about 15 years.

1949

Spring..... Ad Hoc Steering Committee for NEPA project established to provide program guidance, with representation from Air Force, Navy, AEC, and National Advisory Committee for Aeronautics.

November..... AEC begins ANP research project at Oak Ridge National Laboratory.

1950

March..... Aircraft Reactors Branch established in AEC and assumed responsibility for AEC part of NEPA project.

1950

August..... Technical Advisory Board of Ad Hoc Steering Committee reviews NEPA program and generally endorses it.

December..... Research and Development Board of Defense Department recommends program for development of subsonic aircraft for flight in 1956–57 period.

1951

February..... Air Force and AEC agree to close out NEPA project at Oak Ridge as general feasibility is indicated and research and development phase begins. It is decided to shift the program, under joint auspices, to the General Electric Co. for development of a propulsion plant.

Do..... Air Force contracts with Convair Division of General Dynamics Corp. for application studies and initiates "flying testbed" program aimed at first flight in 1957.

Do..... Joint Committee insists that Air Force support the ANP program on a scale sufficient to insure success or cancel it.

March..... Defense Department informs Joint Committee that Joint Chiefs of Staff have established official military requirement for construction of a nuclear powerplant suitable for aircraft propulsion. Air Force Chief of Staff (General Vandenburg) urges AEC to give project high priority.

May..... NEPA project officially terminated and General Electric Co. initiates project aimed at development of a powerplant for eventual flight test. Direct cycle system is decided upon later in the year (October).

1952

April..... Air Force recommends to AEC development of nuclear propulsion system for flight test in subsonic aircraft in 1956–57 period.

1952

May..... AEC approves use of part of National Reactor Testing Station at Arco, Idaho, as flight test base.

July..... AEC and Defense Department inform Joint Committee that plans are being made for flight test of a nuclear propulsion system in the 1956–58 period, utilizing a modified conventional plane as a "testbed" (B–36).

December..... Office for Aircraft Nuclear Propulsion is established to coordinate AEC and Air Force participation in the program, following suggestions by Joint Committee. Maj. Gen. Donald Keirn is named Director of the joint project, as Ad Hoc Steering Committee is phased out.

1953

March..... Ad Hoc Committee of Air Force Scientific Advisory Board recommends cutting ANP program back by 50 percent on grounds that activities are unwarranted by state of the art and rate of progress.

April..... National Security Council orders AEC and Defense Department cancellation of ANP program on grounds of budget savings and contention that program is not in the national interest. Secretary of Defense Wilson subsequently orders program canceled, terming nuclear plane a "shitepoke."

May..... Joint Committee calls urgent meeting to discuss the situation with Under Secretary of Defense Keyes and Secretary of Air Force Talbot. Cancellation of project is termed a misinterpretation of order and it is reported that reorganization of project is underway.

Do..... The flying "testbed" program is terminated, together with most development on direct cycle propulsion system. Schedules for ground and flight test of propulsion system are indefinitely postponed. Program redirected toward applied research and development on a limited fund basis. Under this revised program a series of high temperature reactor experiments (HTRE's) were scheduled to develop and prove out the reactor powerplant.

December..... Air Force informs AEC of its renewed interest in manned nuclear aircraft and asks AEC to expedite experimental work.

1954

April—— General Keirn, Director of ANP project, tells Joint Committee that nuclear propelled aircraft could be in operation in as little as 50 percent of scheduled time, given a high priority.

May—— Joint Committee approves report by its Research and Development Subcommittee calling for a crash effort on the ANP project. Report is transmitted to the President, Secretary of Defense, and Chairman of Atomic Energy Commission.

July—— Joint Pratt & Whitney and Oak Ridge National Laboratory program established to develop indirect cycle propulsion system.

1955

February—— AEC reports that progress on direct cycle reactor has exceeded expectations and authorizes additional funds to be spent during the remainder of fiscal year 1955 in support of direct cycle program.

March—— Air Force issues requirement for high performance nuclear powered aircraft weapons system. Testifies before Joint Committee, indicating that ground test of a prototype of the direct cycle system can be tested in about 1959.

April—— High performance aircraft program initiated, with project office established at Wright Field. Competition for airframe studies is begun.

June—— AEC and Defense Department agree to accelerate ANP program with objective of testing prototype propulsion plant about 1959.

July—— Navy and AEC programs to develop nuclear plane integrated in AEC Aircraft Reactors Branch. Navy expresses interest in subsonic nuclear powered seaplane.

September—— Test aircraft with small irradiation reactor aboard to test radiation effects and shielding was flown.

Do—— Pratt & Whitney is authorized to perform work on indirect cycle reactor. Construction of CANEL (Connecticut Aircraft Nuclear Engine Laboratory) facility is started to accommodate anticipated expansion of ANP program.

November—— Navy requirement for nuclear seaplane is established and AEC assistance in developing propulsion system is requested.

Do—— Air Force directs teamup of General Electric-Convair and Pratt & Whitney-Lockheed to proceed with propulsion systems for high performance aircraft.

1956

January—— First "heater" experiment utilizing a direct cycle reactor with a turbojet engine is carried out successfully at Arco, Idaho.

April—— Navy proposal for third-approach program is disapproved by Defense Department following recommendation by AEC that Navy should utilize efforts of two existing programs.

June—— Air Force Chief of Staff, General Lemay, tells Joint Committee he believes there is strong requirement for nuclear powered aircraft. He expresses interest in achieving nuclear flight at earliest practicable date.

July—— General Keirn tells Joint Committee that ground test of a propulsion system is possible about 1959 and first flight about 1960.

August—— Revised fiscal 1957 program results in 18 months' slippage in program schedule.

November—— Joint Committee informed of Defense Department policy decision to cut back ANP program.

December—— New reactor experiment operates successfully at Arco, Idaho, and logs many hours of turbojet operation from nuclear heat.

Do—— Accelerated program for high performance aircraft canceled following meeting of Defense Department and Budget Bureau officials with the President in Augusta. Direct cycle development continues on reduced basis; indirect cycle effort virtually eliminated. No specific objectives or target dates are retained.

1957

January	Air Force Scientific Advisory Board reviews ANP program. Board recommends less emphasis on engine and airframe development, more on reactor research and development.
February	Ad Hoc Committee of Defense Department (Littlewood Committee) begins review of ANP program.
Do	Joint Committee calls Defense Department and AEC officials to testify on status of program. Committee members urge that measures be taken to achieve early flight for nuclear aircraft prototype. Deputy Defense Secretary Quarles states that no flight date has been set, says none will be until propulsion system developed which is adequate for useful military plane.
Do	Air Force proposes expansion of existing program to include low level subsonic plane.
Do	Ad Hoc Panel of General Officers (Mills Panel) appointed in Defense Department to review ANP program and missions contemplated.
Do	Joint Committee sends letter to Secretary Quarles expressing concern about lack of firm program objectives and lack of centralized direction of program.
April	Joint Committee urges Defense Department to proceed with vigorous ANP program and meets again with Secretary Quarles to emphasize its concern. Secretary Quarles testifies that program objectives have been established for ground and flight test propulsion systems, looking toward first flight in the early 1960's.
April	Littlewood Committee report is issued recommending, inter alia, that ANP development program should be carried through flight test stage.
May	Ad Hoc Evaluation Board of Air Research and Development Command issues report recommending development of low-level nuclear plane (Canterbury Panel).
Do	Budget Bureau sends directives to executive agencies, requiring that fiscal 1959 budget be held at same or lower level than fiscal 1958.
June	Air Force Secretary Douglas sends letter to Joint Committee stating: "We are convinced that early nuclear powered flight testing is an important part of the program. It is believed that accomplishment of actual nuclear flight will crystalize and clarify many of the problems concerning radiation hazards, nuclear powerplant operation and maintenance and the actual capabilities of nuclear powered aircraft."
Do	Mills report recommends that program objective should be early fabrication and flight testing of prototype propulsion system in the early 1960's. Report noted that problems of propulsion system could only be solved through actual test flight; favored test aircraft as immediate objective.
Do	Joint Committee is informed that procedures are being developed for unified project direction under General Keirn for better coordination of AEC and Defense Department activities.
Do	Navy proposes to Defense Department that nuclear turboprop plane concept be adopted.
Do	Joint Committee again meets with Secretary Quarles to discuss ANP and urge vigorous action on early flight.
July	Secretary Quarles approves Air Force program looking toward first flight of experimental aircraft in mid-1960's.
September	Budgetary ceilings cause slippage in time schedule for ground test and flight test of direct cycle system. It is recognized that under budget limitation, Pratt & Whitney effort on indirect cycle cannot be carried on as secondary effort at desired levels.

1957—Continued

October	Defense Department and AEC decide that high level group should be established to review hazards aspects of nuclear plane and make recommendations for national policy. Group is established (Hunsaker Committee) and begins review of program.
Do	Representative Price, chairman of Research and Development Subcommittee, after trip to Russia, sends letter to the President urging early flight program, both for military requirements and for psychological reasons in light of Russia's success with sputnik. Letter expresses concern over lack of well-defined objectives and target dates.
November	Proposals are made within Defense Department that a program looking toward early flight of a nuclear propelled aircraft be instituted, utilizing a direct cycle propulsion system and a modified test aircraft as a flying testbed. No action is taken.
December	Air Force advises Department of Defense of Air Force capability to demonstrate early flight in early 1960's.
Do	Navy advises Defense Department of Navy's intent to proceed with early flight program, utilizing modified seaplane with turboprop engines and direct cycle system. Navy says it is prepared to reprogram its own funds to carry out this objective.
Do	Hunsaker Committee report expresses concern over potential hazards of nuclear flight over land in development period and recommends first flights be made from island or coastal base. Joint Chiefs and service Secretaries, after review of report, express opinion that such action is premature.

1958

January	AEC recommends to executive branch that early flight of nuclear plane should be pursued as means of increasing American scientific prestige in postsputnik era.
Do	President requests his science adviser, Dr. Killian, to review ANP program and Dr. Bacher is appointed chairman of study committee. Bacher group later is reconstituted as Ad Hoc Advisory Committee to the Deputy Secretary of Defense on the ANP Program.
February	Air Force makes strong recommendation to Defense Department on acceleration of early flight program aimed at achieving early flight in the early 1960's with direct cycle system.
Do	Bacher Committee recommends against accelerating early flight program with available materials and that greater emphasis be placed on more advanced materials capable of producing higher reactor performance.
Do	Following meeting with representatives of AEC, Defense Department, Dr. Killian and Dr. Bacher, President decides that accelerated flight program would detract from goal to achieve militarily useful aircraft and disapproves early flight proposals.
March	President responds to Representative Price's letter of previous October, stating conviction that needs for development of a high performance military aircraft override early nuclear flight objective.
Do	Joint Committee meets with Secretary Quarles to discuss Bacher report on ANP program, including recommendations that plans for early flight be subordinated to increased emphasis of fundamental problems of research and development. Joint Committee is informed that the President has approved Bacher report.
April	Joint Committee is given Air Force and Navy briefing which was presented to Bacher Committee. General Keirn reiterates his confidence in direst air cycle system; expresses view new plane should be built for first flight rather than converted conventional plane.

1958—Continued

April—Joint Committee calls members of Bacher Committee to testify on their report. Bacher Committee reiterates its belief that more fundamental research and development work needs to be done before decision is taken for first flight. Representative Price and some committee members indicate that Bacher Committee report is inadequate and not adequately based on firsthand review of work or reports.

June—Strategic Air Command submits formal operating requirement for CAMAL aircraft (Continuous Airborne Missile Launching and Low-level Penetration System).

July—Air Research and Development Command is authorized to initiate design-management competition for selection of airframe contractor by Jan. 1, 1959.

October—Air Force and Navy present proposals to Defense Department for flight program, and are asked to attempt to reach some common ground to satisfy both requirements. Both services conclude that requirements are not compatible and therefore a common program is not possible.

November—Defense Department agrees with AEC that ground test of propulsion system in about 1960 is desirable. Defense Department states that decision on plan for first flight has been deferred.

Do—Air Force and AEC present proposals to Secretary of Defense for accelerated early flight program, calling for reprograming of about $25 million in fiscal 1960 for each agency as added funds.

Do—Third experimental reactor in "Heater" series at Arco begins power tests. Operating incident causes temporary shutdown.

December—Following meeting with the President and Budget Bureau officials, decision is taken to cut back proposed AEC and Defense Department budgets to about $75 million each for fiscal year 1960.

1959

January—Joint Committee receives testimony from Secretary of the Air Force, Secretary of the Navy, and Under Secretary of Defense Quarles on status of ANP program. Committee is informed that both Air Force and Navy have established requirements for nuclear propelled aircraft. Air Force and AEC representatives state that both agencies have recommended reprograming an increase in their own 1960 funds for a flight program but proposals are not approved.

Do—General Keirn estimates that budget cutbacks will result in delay of about 1 year in achievement of a ground test prototype and confirms that no decision has yet been taken on flying program.

February—Secretary Quarles briefs Joint Committee on program, reiterating position that, until materials problems are solved, program would remain oriented toward development of nuclear propulsion system. Decision on nuclear flight would come later.

1959

February—Joint Committee announces scheduling of first public hearings on ANP program for mid-May.

March—Convair selected in competition for airframe contractor.

April—At Joint Committee suggestion, Secretary Quarles and Chairman McCone of AEC accompany members of the committee on personal inspection tour of General Electric project in Evendale, Ohio, for briefing on direct cycle propulsion system development.

1959—Continued

May	Consensus of meeting between representatives of Defense Department and AEC, including Secretary Quarles and Chairman McCone, is that draft recommendation should be prepared for submission to the President calling for an early flight program. Respective staffs are instructed to prepare such a draft recommendation.
Do	Following death of Secretary Quarles, Joint Committee postpones public hearings on ANP program.
Do	Joint Committee meets with Chairman McCone of AEC and Dr. Herbert York, Director of Defense Research and Engineering of the Department of Defense, to receive clarification on intentions with regard to an early flight program. Committee members are promised a report the following month.
June	Deputy Defense Secretary Gates, Dr. York, and Chairman McCone informed Joint Committee of decision to reorient ANP program toward development of more advanced materials and greater emphasis on indirect cycle approach. Committee is informed that decision will result in less work on materials for early flight program and that target dates for ground test prototype and nuclear flight have been eliminated. A delay of at least 2 years in achieving flight test prototype is admitted.
July	Joint Committee announces rescheduling of public hearings on ANP program.

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